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U. S. NAVAL PROVING GROUND
DAHLGREN, VIRGINIA

REPORT NO. 1098

TESTS OF INTERLOCK BETWEEN SALVO LATCH AND GUN CAPTAIN'S READY SWITCH FOR 8-INCH BREECH MECHANISM MARK 9 AND MODS

FINAL Report

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Task Assignment NPG-Re5-1-24-53

Classification CONFIDENTIAL SECURITY INFORMATION

Tests of Interlock Between Salvo Latch and Gun Captain's Ready Switch for 8-inch Breech Mechanism Mark 9 and Mods

PART A

SYNOPSIS

An interlock between the salvo latch and the gun captain's ready switch was designed by the Bureau of Ordnance and the Naval Gun Factory in an effort to improve the operating safety of the current rotating plug, carrier type breech mechanisms, particularly the 8-inch Mark 9.

Several variations of the components of the interlock were sent to the Naval Proving Ground for tests to determine the relative desirability of these units. The interlock was installed on a station 8-inch breech mechanism and was subjected to firing and non-firing tests.

On the basis of the tests conducted it is recommended that an interlock be adopted embodying the following features:

(1) A circuit basically like Model I (Figure 2, Appendix (B)) but with a modification which will keep the "breech closed" light on after the ready switch is shifted to "ready" and until the breech is open. (The manner in which this is handled in circuit Model II is considered satisfactory).

(2) A panel of indicating lights including the following: "Gun Captain Ready", "Breech Latched", "Bore Clear", and "Gun Recoiled", to be mounted where the gun crew can readily see them.

(3) A modified buffer of the type tested but with the gland (Sk. 400271-2) made of bearing bronze instead of steel. It is recommended that hydraulic fluid (51-F-21) be used in this buffer.

(4) A single breech operating lever latch of the standard design except modified with the switch actuator, Sk. 400262-2. (See Figures 12 and 13 of Appendix (C) for an illustration of the combination of buffer and latch described).

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PART B

INTRODUCTION

1. AUTHORITY:

The tests reported herein were conducted under authority delegated by reference (a).

2. REFERENCE:

a. BUORD Conf ltr Re5c-RRK:hsr NP9 Ser No. 46358 of 17 Oct 1952

3. BACKGROUND:

The mechanisms, the tests of which are reported herein, were developed in an effort to improve the safety of operation of current breech mechanisms of the rotating plug, carrier type, particularly the 8-inch Mark 9. This effort was prompted by the recent turret casualty of the USS ST. PAUL (CA-73).

4. OBJECT OF TEST:

The object of the tests conducted was to determine the relative desirability of several variations to an interlock between the salvo latch and the gun captain's ready switch.

5. PERIOD OF TEST:

a.	Date Project Letter	17 October 1952
b.	Date Material Received	20 October 1952
c.	Date Commenced Test	3 November 1952
d.	Date Test Completed	30 January 1953

6. REPRESENTATIVES PRESENT:

All of the following representatives were present on 14 November 1952 to witness a firing demonstration of the subject interlock mechanism. Some of these persons were present at other times throughout the period of the test:

J. B. Colwell, Captain, USN	Bureau of Ordnance	Rex-b
C. A. Dancy, Commander	Bureau of Ordnance	Re5
A. J. Stanton	Bureau of Ordnance	Re5-2
J. C. Phillips	Bureau of Ordnance	Re5c-2
J. E. Graves	Bureau of Ordnance	Re5c-5
R. M. Wills	Naval Gun Factory	Design Section
R. Butterworth	Naval Gun Factory	Design Section
E. C. McCleery	Naval Gun Factory	Design Section
G. W. Rauen	Naval Gun Factory	Design Section

PART C

DETAILS OF TEST

7. DESCRIPTION OF ITEM UNDER TEST:

a. The subject interlock mechanism utilized the following elements:

(1) The gun captain's ready switch. This switch was modified by the addition of a flat coil spring and a solenoid latch. The coil spring was installed in such a manner as to exert a force to return, or hold the switch to the "safe" position. The latch functioned to hold the ready switch in the "ready" position until retracted by the energized solenoid, and also acted as a lock to prevent the ready switch being moved to "ready" until the solenoid was energized.

(2) A switch, which was mounted on the after end of the counterrecoil cylinder immediately above the breech operating lever latch. This switch is actuated by the breech operating lever latch.

(3) The operating lever latch, which was modified by the addition of a switch actuator.

(4) Indicating lights to indicate the following conditions:

Gun recoiled
Bore clear
Breech closed
Gun captain ready
Pointer ready

(5) A manually operated "bore clear" switch.

(6) A manually operated "pointer ready" switch.

(7) Two (2) magnetic relays and appropriate electrical circuits.

b. Modification of the original design resulted in the following additional elements:

(1) A modified breech operating lever buffer. The modification entailed lengthening the buffer plunger. See Bureau of Ordnance Sketch 400271, reproduced as Figure 1 of Appendix (A).

(2) A modified breech operating lever latch. This latch was modified by the addition of a second latch position approximately 2.5 inches behind the first.

c. The Naval Gun Factory prepared two (2) bread-board models of the interlock. The first, hereinafter referred to as Model I, utilized the modified gun captain's ready switch described in paragraph 7 a. (1) above. The schematic circuit drawing of Model I is reproduced as Figure 2 of Appendix (B). The device is pictured in Figures 4 and 5 of Appendix (C). In Figure 4 the ready switch is shown latched in the "safe" position; in Figure 5 it is shown latched in the "ready" position. The second bread-board model of the interlock, hereinafter referred to as Model II, substituted a rotary magnetic relay and push button switch for the gun captain's ready switch of Model I, and in addition had a considerably different circuit. The schematic drawing for Model II is reproduced in Figure 3 of Appendix (B) and a picture of the device is included as Figure 6 of Appendix (C).

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d. Operation of the interlock.

The operation of the interlock is best described by the tables below which indicate the positions of the ready switch and operation of the indicating lights corresponding to the various steps in the sequence of firing the gun.

	Lights On					
	Breech	Bore	Gun Captain		Ready Switch	
Model I	Closed	Clear	Ready	Recoil	Safe	Ready
Gun has fired	X			X	X	
Gun captain opens breech				X	X	
Gun captain closes "bore clear" switch		X			X	
Gun is loaded		X			X	
Gun captain closes breech	X	X			X	
Gun captain closes "ready" switch			X			X
Gun fires and recoils			X	X		X
Gun returns to battery	X			X	X	
Model II						
Gun has fired	X			X	X	
Gun captain opens breech				X	X	
Gun captain closes "bore clear" switch		X			X	
Gun is loaded		X			X	
Gun captain closes breech	X				X	
Gun captain closes "ready" switch	X		X			X
Gun fires and recoil				X		X
Gun returns to battery	X			X	X	

8. DESCRIPTION OF TEST EQUIPMENT:

a.	Gun:	8"/55 Caliber Mark 15 Mod 0 Serial No. 838.
b.	Breech Mechanism:	Mark 9 Mod 8.
c.	Yoke:	Mark 10.
d.	Slide:	Mark 19.
e.	Firing Lock:	Mark 14 Mod 5.

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9. PROCEDURE:

a. The components of the interlock were delivered to the Naval Proving Ground by representatives of the Naval Gun Factory and the Bureau of Ordnance who assisted Naval Proving Ground personnel in their installation on a station 8-inch gun. The interlock, as first installed, consisted of the electrical elements of Model I (see Figures 4 and 5 of Appendix (C)), a standard length single breech operating lever latch, and a standard operating lever buffer (see Figures 8 and 9 of Appendix (C)). This combination was operated during routine firing from the gun and was further tested in non-firing operation.

b. At a later date, representatives of the Naval Gun Factory delivered the additional components which have been previously described. These units, the double operating lever latch, the modified operating lever buffer, and the Model II electrical device were assembled and tested in various combinations (see Figures 10 to 15 of Appendix (C)).

c. On 14 November 1952 the interlock was demonstrated in operation during a routine firing program to the representatives of the Bureau of Ordnance and the Naval Gun Factory listed in section 6 above.

10. RESULTS AND DISCUSSION:

a. The following comments on the interlock were made by the various representatives present on 14 November 1952 during the firing demonstration:

(1) The indicating lights should be arranged on the display panel in the order in which the events which they indicate occur. Thus, from left to right they should be in order as follows: "Pointer Ready", "Gun Captain Ready", "Breech Closed", "Bore Clear", and "Recoiled".

(2) The indicating light labelled "Breech Closed" should be renamed "Breech Latched" in order to eliminate any misinterpretation. Conceivably the breech could be regarded as closed without the operating lever being latched.

(3) In the Model I circuit, the "breech closed" indicating light goes out when the gun captain's ready switch is put to the "ready" position, coming on again when the gun has fired and completed counterrecoil. This condition is considered to be unsatisfactory. It would be desirable that the "breech closed" ("breech latched") light remain lighted continually when the breech is closed. This condition was corrected to some degree in the Model II circuit. The light remains lighted when the ready switch is positioned at "ready" but it goes out during recoil and counterrecoil. The fact that it is out during recoil and counterrecoil is not considered to be objectionable.

(4) The modified gun captain's ready switch, as modified by the Naval Gun Factory, was not considered to be satisfactory for the following reasons:

(a) It is likely that the use of such a heavy flat coil spring to return the switch to the "safe" position would result in short switch life.

(b) The solenoid operated latch did not have sufficient bearing area on the switch handle.

It is understood from representatives of the Naval Gun Factory that the modified switch furnished by the Gun Factory for test is not the type which will be furnished for fleet turrets. The gun captain's ready switch is a responsibility of the Bureau of Ships, and it is further understood that the Bureau has undertaken the design of a new switch for this application.

b. Further comments relative to the interlock, which came about as a result of tests of the device and its various modifications, are listed below:

(1) The standard breech operating lever buffer has a Garlock type packing and conventional packing gland. It is designed to use a glycerine-water fluid. Experience has shown that it is difficult to maintain this buffer in good operating condition. The modified buffer with the lengthened plunger which was manufactured by the Naval Gun Factory (see Figure 1 of Appendix (A)) was constructed using "O"-ring packing, and can be filled with either glycerine-water or hydraulic fluid (51-F-21). The use of "O"-ring packing and hydraulic fluid is considered an improvement over the old style packing and the glycerine-water solution.

(2) During tests of the modified buffer the buffer plunger (Sk. 400271-3) stuck in the gland (Sk. 400271-2) and would not operate. Disassembly revealed that both parts had galled. Both pieces were steel of approximately the same hardness. Upon the recommendation of the Naval Proving Ground a second gland, made of bronze, was furnished by the Naval Gun Factory. Thereafter the buffer performed satisfactorily.

(3) Preliminary tests of a Mark 9 Mod 8 breech mechanism equipped with a Mark 14 Mod 5 firing lock revealed that during closing of the breech the firing lock wedge is positioned over the primer and the firing pin makes contact with the primer before the operating lever is latched. In the breech mechanism used for this test a primer could be fired anytime the operating lever catch was less than 2.1 inches from the operating lever latch. It was this fact that prompted the design of the modified breech operating lever buffer, which employs an elongated plunger and a plunger spring having sufficient force to push the operating lever beyond the 2.1 inch danger zone. (The plunger positively forces the lever 2.45 inches from the latch). Tests were conducted to ensure that this modified buffer could not exert sufficient force to actually open the breech inadvertently. Although the breech mechanism used for the test was not considered to be in perfect condition, the buffer could not be made to move the operating lever beyond 7.5 inches from the latch position. These tests were conducted both with a cold gun and with one warmed from gunfire. It is not felt that this distance would be more than doubled in a breech mechanism perfectly adjusted and lubricated. This amount of movement of the operating lever would correspond to about 5° of rotation of the breech plug. 28° rotation is necessary to unlock the threads plus 5°45' to clear. It is thus evident that the modified buffer cannot inadvertently cause the breech to open.

(4) The long latch with the second latch position at 2.45 inches from the first (see Figures 1, 10, 11, 14, and 15) was designed to prevent inadvertent opening of the breech by the modified buffer. Since this cannot happen anyway, this long latch is considered to be unnecessary, and in addition, somewhat of a hazard to the plugman since it protrudes some distance out from the salvo latch bracket where it could conceivably be in the way of the movements of the plugman's head.

PART D

RECOMMENDATIONS

11. On the basis of the tests conducted it is recommended that an interlock be adopted embodying the following features:

(1) A circuit basically like Model I (Figure 2, Appendix (B)) but with a modification which will keep the "breech closed" light on after the ready switch is shifted to "ready" and until the breech is opened. (The manner in which this is handled in circuit Model II is considered satisfactory).

(2) A panel of indicating lights including the following: "Gun Captain Ready", "Breech Latched", "Bore Clear", and "Gun Recoiled", to be mounted where the gun crew can readily see them.

(3) A modified buffer of the type tested but with the gland (Sk. 400271-2) made of bearing bronze instead of steel. It is recommended that hydraulic fluid (51-F-21) be used in the buffer.

(4) A single breech operating lever latch of the standard design except modified with the switch actuator, Sk. 400262-2. (See Figures 12 and 13 of Appendix (C) for an illustration of the combination of buffer and latch described).

PART E

DISPOSITION OF MATERIAL

12. It is understood from the Bureau of Ordnance that the components of the interlock tested at the Proving Ground will be collected by representatives of the Naval Gun Factory for subsequent assembly and test aboard an operating 8-inch cruiser. The components are being held for these representatives.

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Tests of Interlock Between Salvo Latch and Gun Captain's Ready Switch for 8-inch Breech Mechanism Mark 9 and Mods

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NPG REPORT NO. 1098

U. S. NAVAL PROVING GROUND
DAHLGREN, VIRGINIA

Final Report
on
Tests of Interlock Between Salvo Latch and Gun Captain's Ready Switch for 8-inch Breech Mechanism Mark 9 and Mods

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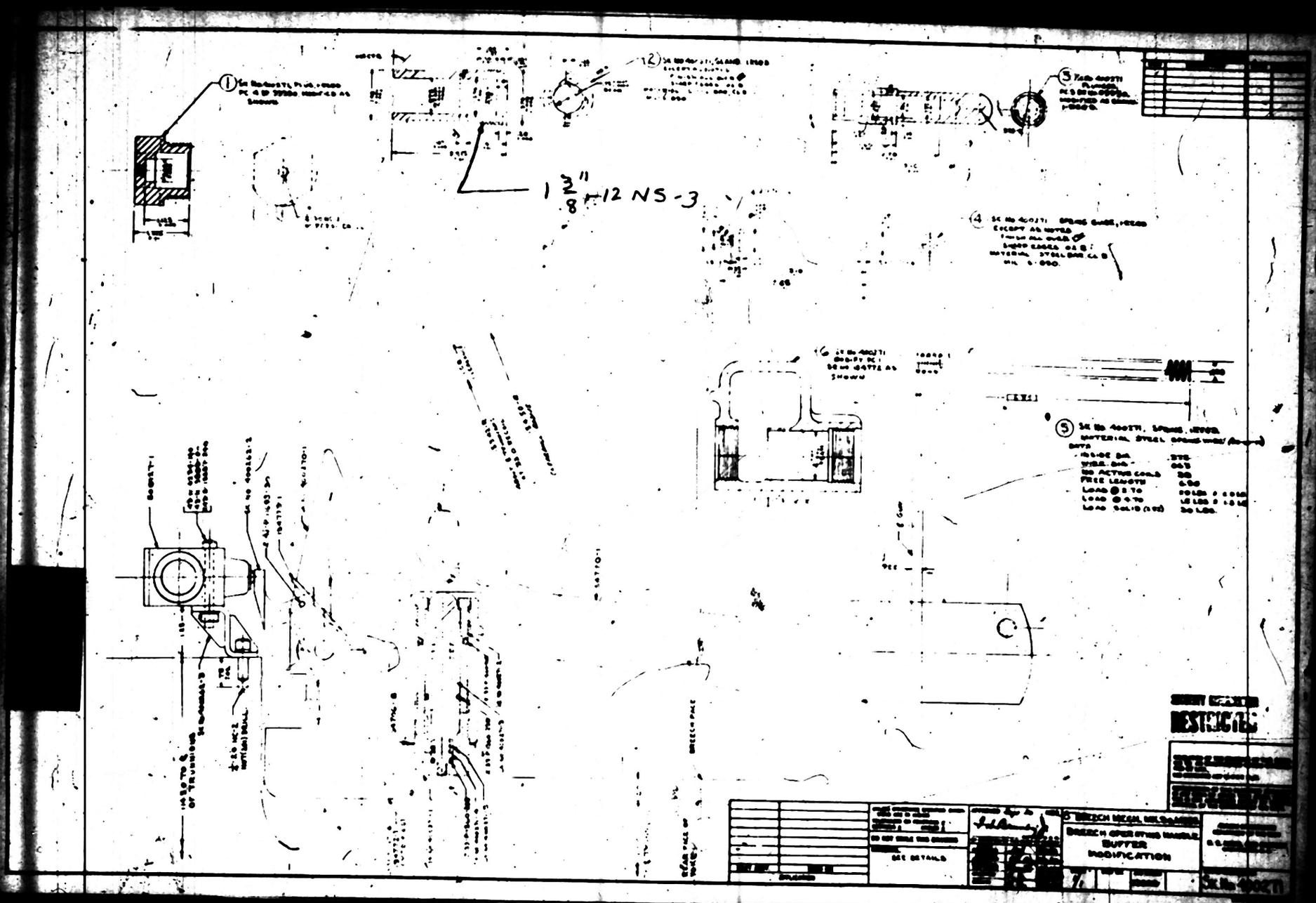
1 3/8"-12 NS-3
BREECH MECHANISM
BREECH OPERATING HANDLE
BUFFER
MODIFICATION

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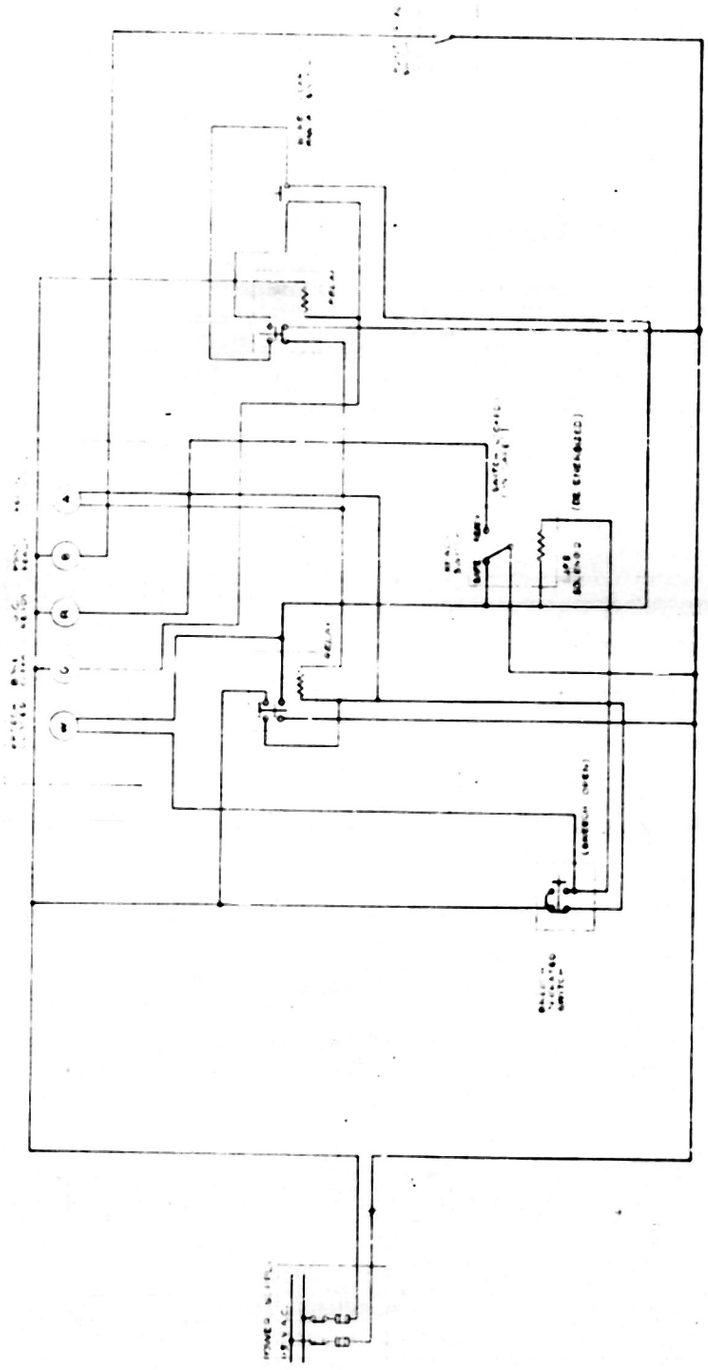

Figure 2
Appendix (B)

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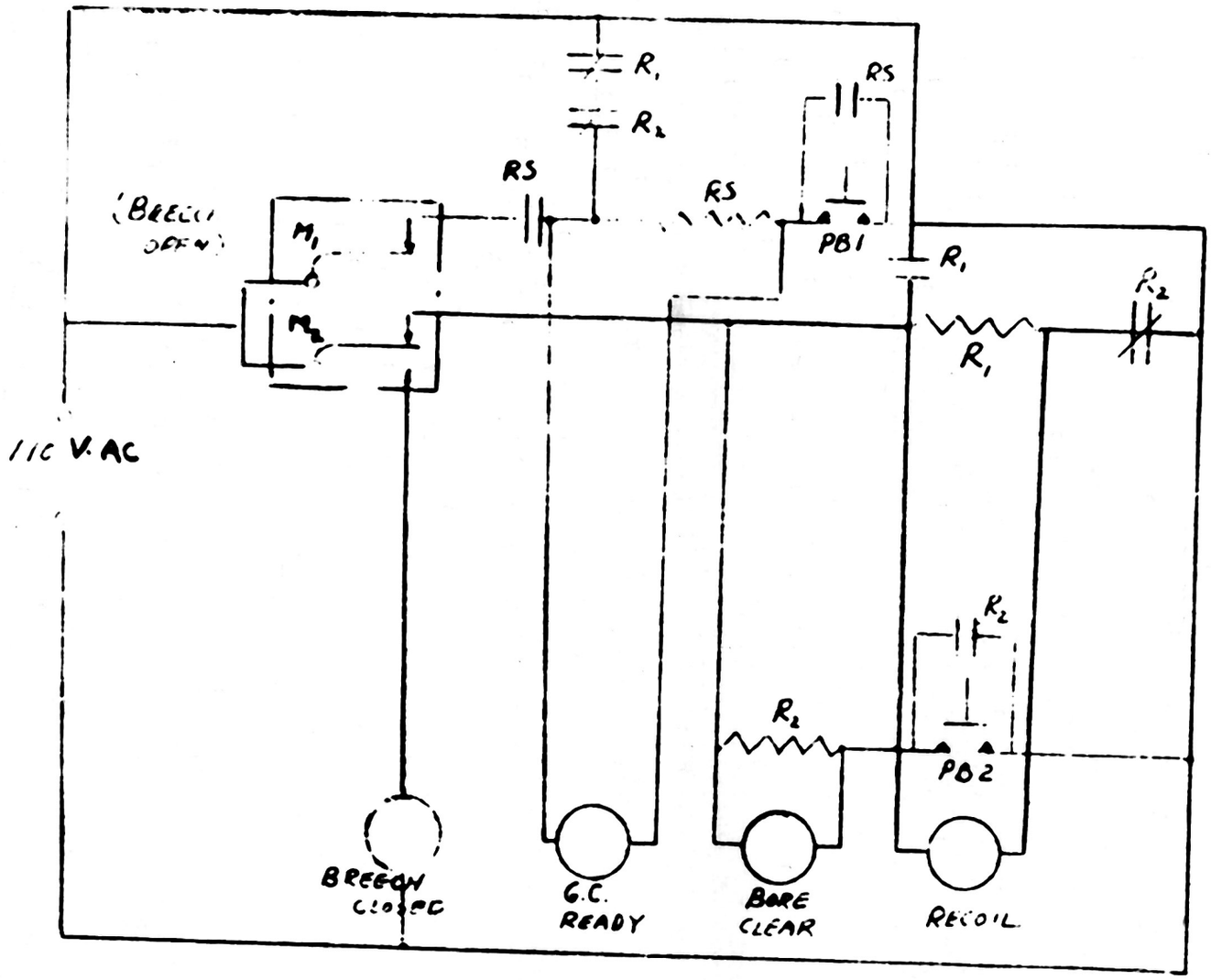
8 INCH BREECH MECHANISM INTERLOCK CIRCUIT.



RELAYS: RS (READY SWITCH), R_1 & R_2

PUSH BUTTONS: PB1 (READY) & PB2 (BORE CLEAR)

MICRO SWITCHES: M_1 & M_2 (BOTH BREECH-OPERATED)

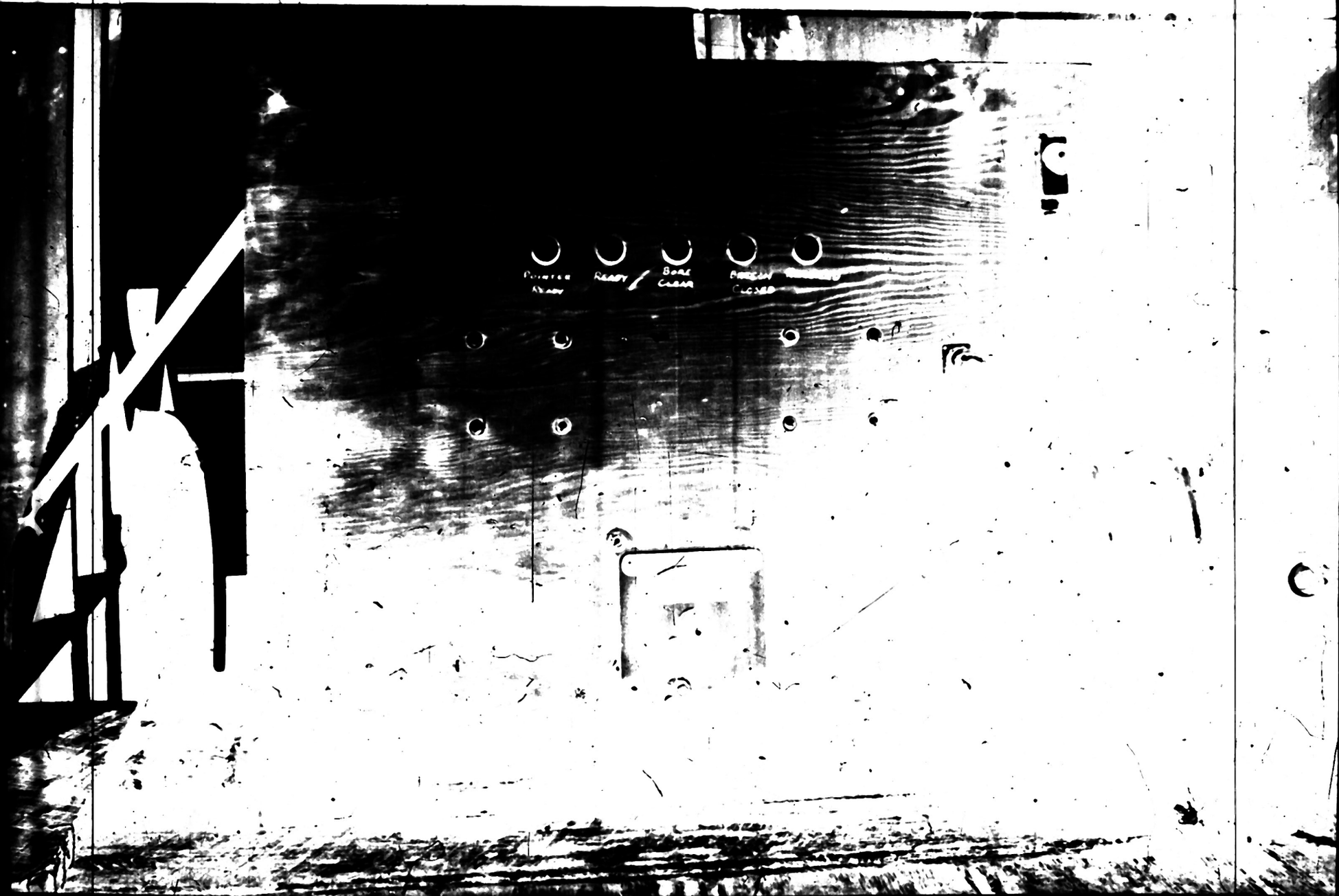
Figure 3
Appendix (a)

-inch Salvo Latch - Ready Switch Interlock. Model 1 electrical elements. Gun captain's ready switch is shown latched in "safe" position. Switch at upper right is "bore clear" switch.

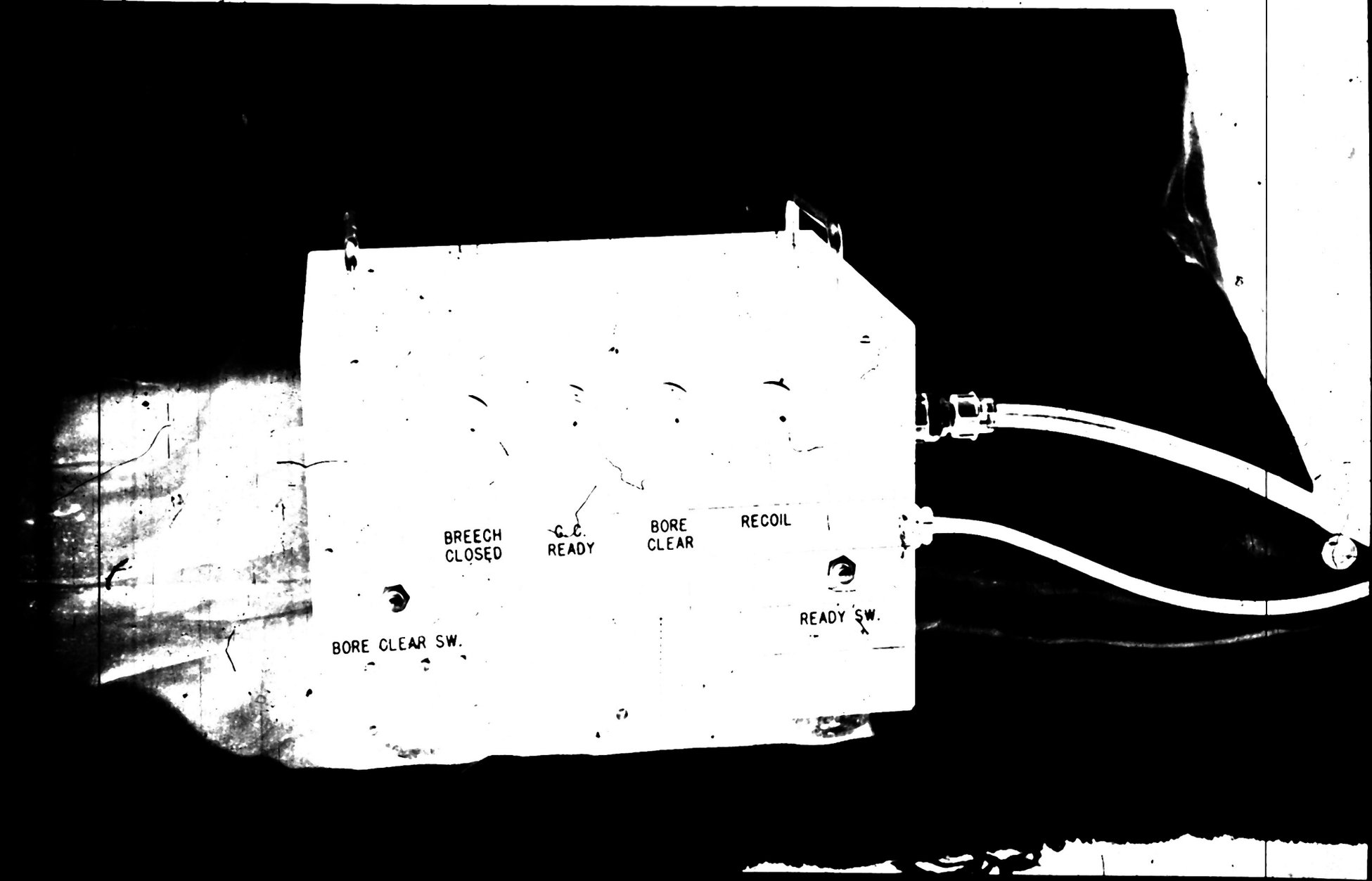
Figure 4

8-inch Salvo Latch - Ready Switch Interlock. Model I electrical elements. Gun captain's ready switch is shown latched in "ready" position. Switch at upper right is "bore clear" switch.

Figure 5



8-inch Salvo Latch - Ready Switch Interlock. Model II electrical elements.
Figure 6 Appendix (C).



8-inch Salvo Latch - Ready Switch Interlock. General view of 8-inch Mark 9 Breech Mechanism, closed and latched. Interlock switch mounted on counter-recoil cylinder above breech operating lever is visible at top of photograph.

Figure 7

8-inch Salvo Latch - Ready Switch Interlock. View showing the standard breech operating lever buffer with the single operating lever latch. Operating lever in this view is latched; switch indicates breech closed.

Figure 8

8-inch Salvo Latch - Ready Switch Interlock. View showing standard breech operating lever buffer with single operating lever latch. Operating lever is unlatched; switch indicates breech open.

Figure 9

8-inch Salvo Latch - Ready Switch Interlock. View showing standard breech operating lever buffer with the modified (double) operating lever latch. Lever is latched; switch indicates breech closed.

Figure 10

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8-inch Salvo Latch - Ready Switch Interlock. View showing standard breech operating lever buffer with modified (double) operating lever latch. Operating lever is not fully latched switch indicates breech open.

Figure 11

Appendix (C)

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5-inch Salvo Latch - Ready Switch Interlock. View showing modified (long) breech operating lever buffer with single operating lever latch. Operating lever is latched; switch indicates breech closed.

Figure 12

Appendix (C)

8-inch Salvo Latch - Ready Switch Interlock. View showing the modified (long) breech operating lever buffer with the single operating lever latch. Operating lever in this view is not latched; switch indicates breech open.

Figure 13

8-inch Salvo Latch - Ready Switch Interlock. View showing the modified (long) breech operating lever buffer with the modified (double) operating lever latch. Operating lever in this view is latched; switch indicates breech closed.

Figure 14

8-inch Salvo Latch - Ready Switch Interlock. View showing the modified (long) breech operating lever buffer with the modified (double) operating lever latch. In this view the operating lever is not fully latched; the buffer forces the lever out against the second latch position; the switch indicates breech open.

Figure 15

Tests of Interlock Between Salvo Latch
and Gun Captain's Ready Switch
for 8-inch Breech Mechanism Mark 9 and Mods

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